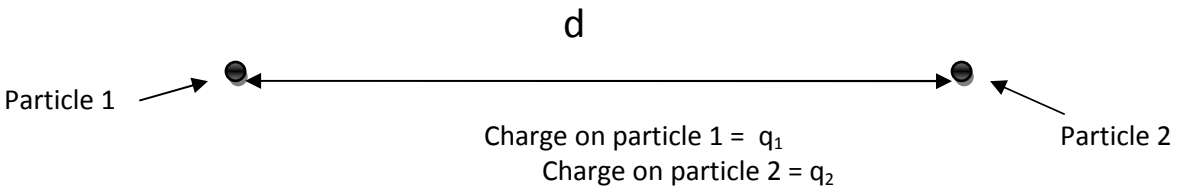
KIM

COULOMB'S LAW:

INFORMATION MODEL: Two charged particles separated by a distance "d"




Charge on particle 1 = $q_1$

Charge on particle 2 = $q_2$

$$V = \frac{kq_1q_2}{d}$$

Coulomb's law: The potential energy (V) of two stationary charged particles is given by the equation above, where $q_1$ and $q_2$ are the charges on the particles (for example, -1 for an electron), d is the separation of the particles in pm (1 pm = $10^{-12}$m), and k is a positive proportionality constant.

**Key Questions.**

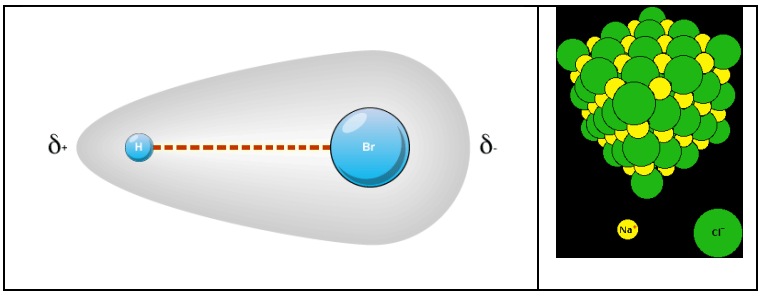
1. If $q_1$ and $q_2$ remain constant, what happens to the magnitude of V if the separation, d, is increased?

2. If the two particles are separated by an infinite distance, i.e., d = ∞, what is the value of V?

3. If d is finite, and the particles have the same charge, i.e., $q_1 = q_2$, is V > 0 or V < 0?

**Exercises.**

4. If q for an electron is -1,
   - what is q for a proton?
   - what is q for a neutron?
   - what is q for the nucleus of a carbon atom?
   - what is q for the nucleus of a fluorine atom?



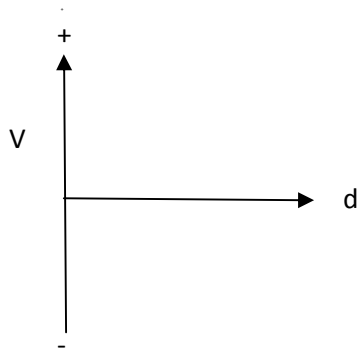




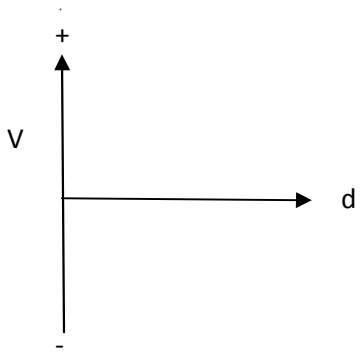
5. So far, we've only been discussing protons, electrons, and nuclei. Remember ionic compounds, as well as polar and nonpolar covalently bonded compounds? How do the charges on a polar molecule compare to the charges within an ionic compound (e.g. HBr versus NaCl)?

6. On the diagrams below, sketch a plot of V vs. d for

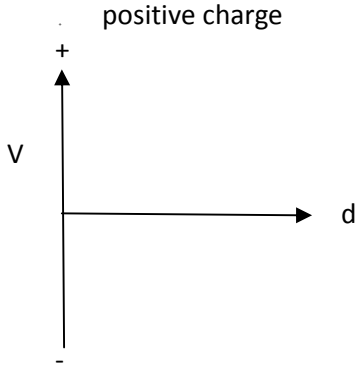
a) two positive charges




b) two negative charges




c) one negative and one positive charge




7. What is the sign of V when there is a force of attraction between particles?

8. What is the sign of V when there is a force of repulsion between particles?

**Problems:**

9. **(READ ME, UNDERSTAND ME, REMEMBER ME): One scientific definition of stability is that a more stable system has a lower energy than a less stable system.**
    - With respect to potential energy, which is more stable, a 1s or a 2s electron (assume nuclear charge stays the same)? Why?
    - With respect to potential energy, which is more stable, a 1s electron in a fluorine atom or a 1s electron in an iodine atom? Why?

10. State the relationship between potential energy, charges, distance between charges, and stability in grammatically correct English.

KIM

**PRACTICE EXERCISES**

COULOMB'S LAW:

In the activity we did in class, we used the formula for electrostatic **potential energy**, we are going to slightly modify that formula to solve for electrostatic **force**. (Energy = force x distance) Use the following formula for the homework problems:

$F_e = \frac{q_1 q_2}{d^2}$ where $q_1$ and $q_2$ are charges, d is the distance between their centers, and $F_e$ is the electrostatic force (of attraction or repulsion)

A larger magnitude (larger absolute value) = stronger force

1. A quick review: What is the sign of $F_e$ when the force is attractive? When the force is repulsive?

2. What type of force has a lower potential energy—attractive or repulsive force?

3. What factors alter the magnitude of the force (i.e. how big the absolute value is)?

4. Let's assume that we are looking at the **attractive** force between +1 charge and a -1 charge at a certain distance d from each other. Compare this original force with the force that results when:
   - the charges are moved twice as far apart?
   - the charges are moved toward each other to a distance which equals 1/3 of their original separation?
   - each charge is halved in magnitude (e.g. +1/2 and -1/2)?
   - each charge is doubled in magnitude (e.g. +2 and -2)?
   - each charge is doubled in magnitude AND moved to a distance double the original distance?

5. Summarize: WRITE ANSWERS IN FULL SENTENCES THAT DO NOT BEGIN WITH A PRONOUN:
   What happens to the magnitude strength of the attractive force between two oppositely charged particles when:
   - the charges' magnitude increases?
   - the charges move closer together?